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Inquiry–Based Instruction for Students with Special Needs in School Based Agricultural Education

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Educating students with special needs in school based agricultural education (SBAE) is a problem that should be addressed. While many students in SBAE classes have special needs, contradicting research exists establishing the best method of instruction for students with special needs. Inquiry–based instruction shows some promise, but little is known about its effectiveness in SBAE settings for students with special needs. The purpose of this study was to determine if inquiry–based instruction impacts content knowledge achievement for students with special needs. A one–group pretest–posttest, design was used to determine if students with an Individualized Education Plan (IEP) differed in content knowledge achievement from those students without IEPs. No difference in content knowledge achievement was found between students with IEPs and those without over seven pre and post tests using ANCOVA measures. Based on these findings inquiry–based instruction can be an effective method of instruction for students with special needs and should be used when appropriate.

Keywords: Inquiry–based instruction, special needs, agricultural education

Introduction

How to best meet the educational needs of students with special needs has been the elephant in the room for agricultural education for some time. Even though it is an issue that needs to be addressed, little has been done to determine the best ways to educate these students in School Based Agricultural Education (SBAE) settings. Despite the fact that the reauthorization of the Perkins Vocational Act in 2006, which is based on prior authorizations of the Perkins act, mandated appropriate vocational education be provided to students with special needs, little research has surfaced from the agricultural education community on how best to educate these students. Dormody, Seevers, Andreasen, and VanLeeuwen (2006) found 19% of SBAE students in New Mexico had an Individualized Education Plan (IEP), compared to 23% in Illinois (Pense, 2008).

The Individuals with Disabilities Education Act of 2004 (IDEA) requires that students with special needs receive individualized instruction that meets their needs in the least restrictive environment (Kinder, Kubina, & Marchand–Martella, 2005). For most students with special needs this includes being mainstreamed into the regular classroom for at least part of the school day. Ninety–seven percent of students with disabilities are in general education courses for at least 40% of the day (Smith, 2007).

According to Tomlinson (2001), students learn in classrooms where they are actively involved in the learning process and are appropriately challenged according to their ability level. In any classroom some students will be more cognitively advanced or more familiar with the skills or content than other students. These more advanced students tend to do well in school but often are not challenged and may fail to develop studying and coping skills. Struggling learners also have their own challenges to overcome. These challenges can stem from any number of sources including problems at home or a genetic or developmental disability (Tomlinson, 2001).

Students with special needs historically take agricultural and other Career and Technical Education courses to prepare them for careers

(Wonacott, 2001). According to Wonacott, students with disabilities were less likely to drop out and were more likely to be employed if they were involved in career and technical education. Eisenman (2000) found through qualitative measures that students with special needs had higher academic achievement and postsecondary engagement when involved in a career and technical education program. According to Gaona (2004), students with special needs benefited from career and technical education because the hands on activities in these courses that engage the students in the curriculum and allow students to practice skills that help them transition to employment.

According to Richardson (2005), expert teachers apply beneficial instructional modification and employ a variety of instructional modifications to meet the needs of learners with special needs. While various methods are being used and a variety of instructional modifications are being made, a limited amount of research exists on which modifications and methods work best in the SBAE classroom. This study was conducted to determine if inquiry–based instruction impacts content knowledge achievement for students with special needs in SBAE so that instructors can confidently choose methods of instruction that are appropriate for their students.

Educating students with special needs can be difficult. If these students make up around a fifth of the agricultural education student population, efforts are needed to determine if current methods of instruction are relevant for this group and if not, new instructional methods need to be developed that meet the needs of these learners.

Inquiry–Based Instruction as an Instructional Model

Inquiry–based instruction is a method of instruction that encourages the use of the scientific process to find the answers to questions. Scientific inquiry in the classroom focuses on science as a process rather than just the memorization of facts (National Research Council, 2000). Conducting scientific inquiry in the classroom requires instructors to facilitate instruction where the students identify and pose questions, design and conduct investigations, analyze data and evidence, use models and explanations, and effectively communicate their findings (Keys & Bryan, 2001).

For this study inquiry–based instruction served as the model of instruction under investigation. The inquiry–based instruction model stresses the learning and thinking process rather than just the acquisition of specific skills. An advantage of using inquiry–based instruction for students with special needs is that it promotes the thinking process and teaches students how to process information in addition to skill and knowledge development. In essence, the focus of inquiry–based instruction is more on the actual process of learning than the understanding of specific concepts. The inquiry–based instruction model operates under the idea that if students are comfortable with the process of learning and can engage in the scientific process they can construct knowledge about new concepts and transfer knowledge from other concepts (Doolittle & Camp, 1999; Frew & Klein, 1982; NRC, 2000).

Research on Inquiry Based Instruction

According to Huber, Smith, and Shotsberger (2000) students taught using inquiry–based instruction have higher perceptions of science and have an increased achievement in science. The findings of Von Secker (2002) report that students being taught using inquiry–based instruction had higher content knowledge achievement than did students taught through other means. In a two year study Geier, Blumenfield, Marx, Krajcik, Fishman, Soloway et al. (2008) found that inquiry–based instruction increased scores on standardized tests compared to other methods. Wolf and Fraser (2007) found that inquiry–based instruction has merits over a short time. They found that 1–2 inquiry–based instruction lessons increased students' attitudes about learning science as well as task orientation.

Inquiry for Students with Special Education

Merchand–Martella, Slocum, and Martella (2004) claimed that direct instruction should be used to educate students with special needs because the content is overtly presented to them and can be modified at an individual level. Other scholars have found benefits to using inquiry–based instruction to educate students with special needs. Scruggs, Mastropieri, Bakken, and Brigham (1993) found inquiry–

based instruction had a more positive effect on students' vocabulary, factual recall, and application test questions scores than text based approaches. They found that inquiry–oriented approaches helped facilitate the acquisition of content knowledge by students. They also noted that when taught through inquiry–oriented approaches, students learned and remembered more and also enjoyed learning more.

Fuller (2001) found that students involved in special education and inclusion settings performed comparably to regular education students when comparing perceived change in teaching and learning component scores in their classrooms. The study also found that there was little difference in the effectiveness of inquiry in the classroom when comparing these same class types. No significant difference was found between classroom types in how much the students enjoyed inquiry–based instruction. These findings indicate that inquiry instruction can be relevant for learners with special needs and an effective way to teach science concepts.

Conceptual Framework

This study was guided by a conceptual model adapted from Mitzel (1960), Dunkin and Biddle (1974), and Singer and Moscovici (2008). The model identifies the presage, context, process, and product variables that were considered for this study and explains either how the variables were controlled for or identified the limitations of the variables observed in this study. The structure for the model was developed by Dunkin and Biddle (1974). The IMSTRA (Immersion Structuring Applying) framework for inquiry–based instruction was developed by Singer and Moscovici (2008) and is used to explain inquiry–based instruction as it was used this study.

Presage Variables

Presage (teacher) variables identify teacher differences. Some examples of presage variables could include experience level, teacher training, age, and preferred learning style. All teachers are different, and these differences are important to consider (Duncan & Biddle, 1974; Mitzel, 1960). For this study selected teachers have similar experience levels (more than three years), and have received similar training efforts, have been made to hold presage variables as a constant, as much as possible. However variations of the other presage variables are an expected limitation. Since all presage variables cannot be controlled, any effect found cannot be contributed solely to the treatment. For analysis purposes an assumption has been made that these factors had no influence on the product variable, thus the influence of other presage variables is beyond the scope of the present study.

Context Variables

Students in any classroom can differ drastically. Their home life, the amount of sleep they have had, their background knowledge and their learning preferences could have an influence on how the students learn in the classroom. These variables are known as context variables. For this study IEP status was the context variable of interest. Thus findings are limited in scope to this single context variable.

Process Variables

The process variable refers to the method of instruction used by the instructor to deliver the content. The process variable can be the teaching method used, or specific delivery for the content (Mitzel, 1960; Duncan & Biddle, 1974). For this study, inquiry–based instruction as defined by the NATAA was used to deliver the content to the students. The instructors that participated in this study attended the conference and received instruction on implementing the treatment in a similar manor, therefore the process variable was held as a constant throughout the study.

IMSTRA Framework

In order to conceptualize the tenets of inquiry–based instruction used in this study the IMSTRA (Immersion Structuring Applying) framework for the teaching and learning cycle was used to conceptualize the process variables. The IMSTRA framework for the teaching and learning cycle outlines the inquiry–based instruction process in a cyclical model. The framework identifies both student and teacher variables that take place during the process of inquiry–based instruction. The framework is based on constructivist principles and built on the idea that the learner is an autonomous thinker that constructs his/her own knowledge.

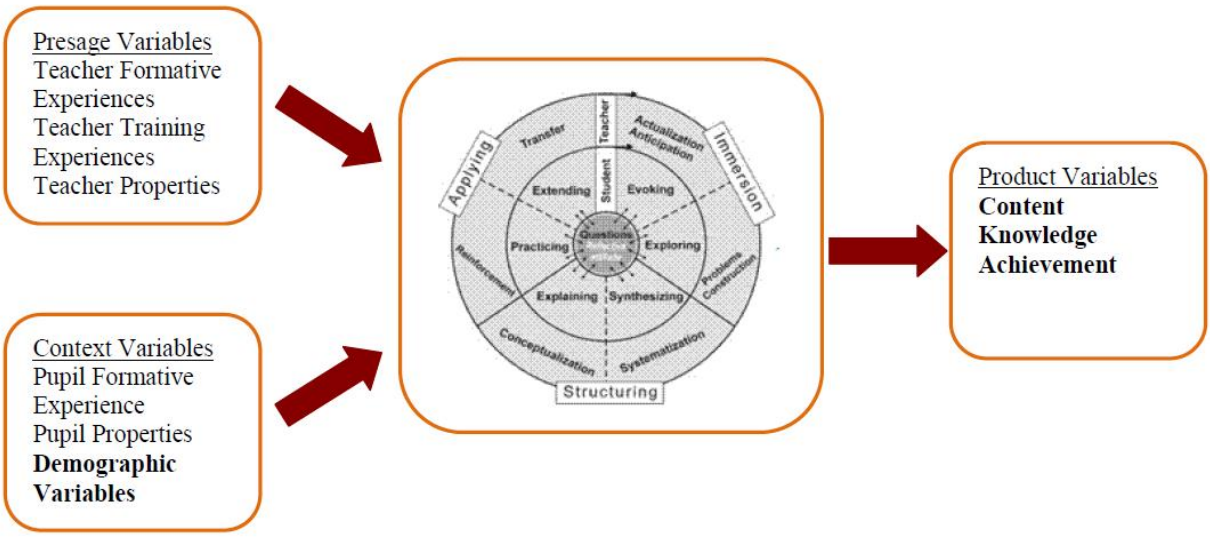

Figure 1. A model for the study of classroom teaching (Dunkin & Biddle, 1974) including the IMSTRA framework for teaching and learning (Singer & Moscovici, 2008) as it relates to this study

The model uses three key stages to explain the inquiry–based instruction process; Immersion, Structuring, and Applying. In the Immersion phase, students begin to address a problem or issue. Here the students are encouraged to seek more information about the phenomena or problem, which may not have an obvious answer. In the second phase, Structuring, students begin to try to explain the problem presented during the Immersion phase. Here students may test hypothesis, relate the problem to other problems, or seek abstract conceptualization to make sense of the problem. During the final stage, Applying, students apply the abstract pattern that they learned during the Structuring phase to apply it to other situations. During the Applying phase, teachers are interested in assessing what students learned and determining their ability to apply it to various situations.

The IMSTRA framework for the teaching and learning cycle can help teachers and students understand the inquiry process. As the circular nature of the model implies, each cycle of the model should lead into the next cycle. Inquiry–based instruction should build on itself so larger concepts can be linked together.

Product Variable

The product variable is the measureable outcome performed by the student. The product variable measures knowledge or skills gained by the student. Quantifying knowledge gain can be a difficult process. Standardized tests based on precise curriculum are typically used by school systems to measure learning. This method of measurement typically makes it easier for school systems, states, and more recently federal government to make comparisons among students and school (Geier et al., 2008). Assessments based on precise curriculum were used for this study to measure content knowledge achievement.

Purpose and Objectives

The purpose of this study was to determine if inquiry–based instruction (process variable) impacts content knowledge achievement (product variable) for students with special needs (context variable). In order to achieve the

purpose of this study the following research hypothesis was tested:

H_o: There is no significant difference in content knowledge achievement score for students taught using inquiry–based instruction based on student IEP status.

Methods

This study utilized a one–group pretest–posttest design (Campbell & Stanley, 1963). This design was selected because random assignment of subjects was not practical. Moreover, a true control group that receives no treatment as defined by Campbell and Stanley (1963) would not have been ethical since the students in the study were expected to learn the content of their course. Only one group was needed because IEP status served as the variable of interest for the study allowing the non IEP group to serve as the comparison group. Ten graduates of the NATAA program were selected by NATAA instructors to participate in this study. Instructors were given the curriculum at the beginning of the school year to allow time to review the material and plan the instruction accordingly. Instructors administered a pretest to gauge base knowledge, and then taught a 10–12 week inquiry–based unit about properties of soils to their agricultural education students. The 10–12 week inquiry–based instruction treatment was split into seven lessons guided by specific student learning objectives. The lesson plans were developed by the researchers and utilized inquiry–based instruction methods. The lessons were adopted from Center for Agricultural and Environmental Research and Training (CAERT) curriculum materials. The pretest and posttest were developed by the researchers based on the CAERT curriculum. Content and face validity of the lessons, pretests, and posttests were validated by a panel of experts compromised of faculty from the Agricultural Education and Communication Department and the School of Teaching and Learning at the University of Florida. The treatment was inquiry–based instruction delivered by an experienced agricultural teacher that has attended the National Agriscience Teacher Ambassador Academy (NATAA). The study utilized a series of seven treatment periods with a pretest and posttest used to measure content knowledge before and after each lesson respectively. The pretest was given prior to the treatment, and then the treatment was delivered, followed by the posttest. The lesson typically lasted 1–2 weeks. This pattern was followed for all seven lessons. Through the course of the study students were referred to solely by their subject ID number on the pretest, posttest, and demographic sheet to maintain student confidentiality. The study took place as part of a larger quasi–experimental design study that compared inquiry–based instruction to the subject matter approach.

The theoretical population of this study was agricultural education students in the United States. However since the participants of this study were limited to 204 students instructed by a graduate of the NATAA program the results are not generalizable to the larger population of agricultural education students. The NATAA is a weeklong, residential, professional development program that allows experienced agriculture teachers to develop their ability to teach inquiry–based instruction through intense hands on and experienced based training. Ten experienced agricultural teachers who have previously completed the NATAA program were selected to participate in the study. The instructors have employed inquiry strategies in their classrooms and have conducted professional development workshops on inquiry instruction to other teachers and educational professionals since completing the program. Each instructor taught inquiry–based lessons to one class of approximately 20 students. To help ensure the consistency of treatment, these instructors have all received the same training on inquiry–based instructions and were given special instructions and training regarding participation in the research project. Since the instructors selected to participate in this study were graduates of the NATAA program, the results are limited to instructors that have graduated from the NATAA program therefore the results cannot be generalized to the agricultural education student population at large. The effect of inquiry–based instruction taught by instructors that have not received the training provided by the NATAA program cannot be determined by this study.

A formula to determine sample size determined that a minimum of 60 participants were required to have an appropriate sample size. A 50% attrition rate can be expected so this

number was doubled to 120 (Myers, 2004). In order to obtain 120 students, 10 intact courses were used. Students missing more than 25% of the instructional time during the treatment period were deemed to not have received the treatment and thus were removed from the study (Thoron & Myers, 2010).

Upon the conclusion of each inquiry lesson the instructors administered a posttest to gauge the students' content knowledge achievement. The pretest and posttest were different forms of the same test. The pretest and posttest were developed by the researcher and piloted to a group of undergraduate agricultural education students and found to be reliable equivalent instruments. The seven instruments were determined to have a coefficient alpha of: .94, .93, .91, .86, .87, .89, and .91 respectively.

An assumption had to be made that instructors modified instruction for students with special needs according to their IEP. Since the instructors in the study were experienced agricultural educators and have legal responsibilities to modify instruction, this assumption could be made. This assumption served as a limitation of the study.

Data was collected using various measures. Demographic data, including IEP data was collected using a Microsoft® Excel® form created by the researchers. The demographic form was then saved to a USB flash drive and mailed to the researchers. The content knowledge achievement assessments were completed by the students, and then the results were saved on a flash drive and mailed back to the researchers. The digital audio recordings of the lessons were taken using a digital audio recording device given to the instructors prior to the study. The digital audio files were then saved on a USB flash drive and shipped to the researchers upon the conclusion of the study. Samples of digital audio recordings were used to ensure the treatment was delivered. This study received IRB approval before the study began.

Data were analyzed using SPSS® version 16.0 for Windows® software package. The posttest scores served as the dependent variables, and the results were analyzed using an analysis of covariance (ANCOVA) where the pretest served at the covariate. The independent variable was the student IEP status.

Results

A total of 204 students were enrolled in the selected classes used in this study. No data was received from three of the schools participating in the study. In one case repeated contacts were made to the instructor. After the study was completed the instructor contacted the researcher and explained their inability to participate due to personal health reasons. A second instructor incurred family medical issues and asked to withdraw from the study. Finally, a third instructor withdrew from the study during the first week because of being assigned a new teaching role that did not meet the guidelines of the study. A total of 27 students were removed from the study due to non–participation. Seven further students were removed from the study due to missing more than 25% of the instructional time during the semester. A final *n* of 170 students participated in the study.

A coefficient alpha for the dichotomous data of content knowledge achievement (CKA) exams was calculated by assessing pilot test results in order to determine the reliability of the pretests and posttests, which were different forms of the same assessment. The posttest questions were asked in a randomly selected order to reduce the overall testing effect (Campbell & Stanley, 1963). The seven CKA pretest and posttests had a mean summated score of 48.2, 50.0, 47.8, 48.2, 56.9, 45.3, and 57.5 respectively. A Kuder–Richardson–20 [KR20] for dichotomous data was used to determine the coefficient alpha (Gall, Borg, & Joyce, 1996).

Audio recordings were analyzed to ensure teachers were correctly implementing inquiry–based instruction. The Science Teaching Inquiry Rubric (STIR) was used as an assessment tool to analyze the level of inquiry–based instruction for each class. All seven teachers in the study effectively delivered inquiry–based instruction.

Instructors were asked to indicate whether or not the students were assigned an IEP. In this study 79.4% (n = 135) did not have an IEP assigned to them, 20.6% (n = 35) did have an IEP assigned to them. There were various reasons for the assignment of the IEPs, 13.5% (n = 23) were described as "other", 2.9% (n = 5) were described as having specific learning disability, 1.2% (n = 2) were described as having a speech or language impairment, 1.2% (n = 2) were described as having a visual impairment,

1.2% (*n* = 2) were described as having an emotional disturbance, 0.6% (*n* = 1) were described as having an orthopedic impairment (see Table 1).

Table 1
Summary of IEP Classifications

Learning Disability	*n*	%
Other	23	13.5
Specific learning disability	5	2.9
Speech or language impairment	2	1.2
Visual impairment	2	1.2
Emotional disturbance	2	1.2
Orthopedic impairment	1	0.6

Since this study utilized a small portion of school based agricultural education population these results are not generalizable to the larger population. Demographic data of the students in this study serve to compare the classes in this study to larger studies of agricultural education students and determine if the sample represents the population of students in school based agricultural education.

H_o: There is no significant difference in content knowledge achievement score for students taught using inquiry–based instruction based on student IEP status.

The effect of inquiry–based instruction on content knowledge achievement based on student IEP status was analyzed using ANCOVA measures. The post–test measuring content knowledge achievement served as the dependent variable, the pre–test served as the covariate, and the fixed variable was student IEP status. A *p* value less that .05 was determined to be significant. For all seven tests IEP was not a significant fixed variable, and did not explain a significant amount of the difference in post–test scores when pre–test scores were controlled for (see Table 2).

Table 2
Summary of ANCOVA Measures for Content Knowledge Achievement Post Assessments for IEP Status

Source	*df*	*F*	*p*
Test 1	1	0.51	.48
Test 2	1	0.13	.72
Test 3	1	1.39	.24
Test 4	1	1.38	.24
Test 5	1	0.11	.74
Test 6	1	0.27	.60
Test 7	1	0.30	.59

IEP status had no significant impact on students' content knowledge achievement scores. While a comparison of means does not indicate a statistical significance, a comparison of means and standard deviations shows that there is little difference between the IEP and no IEP groups (see Table 3).

Table 3
Summary of Central Tendency Measures for the Seven Unit Content Knowledge Achievement Pre and Post Assessments

	IEP $n = 35$		No IEP $n = 135$	
Source	*M*	*SD*	*M*	*SD*
Test 1	61.98	16.55	63.88	18.22
Test 2	64.69	13.70	66.64	15.17
Test 3	65.37	16.80	69.01	15.59
Test 4	74.40	18.53	77.01	12.11
Test 5	78.43	12.94	79.19	12.73
Test 6	80.57	8.52	81.93	10.75
Test 7	81.14	9.53	80.56	10.90

Conclusions

Conclusion 1: The IEP makeup of the population in this study is similar to those found in previous studies.

In this study 20.6% of the students had IEPs. Dormody et al. (2006) found 19% of New Mexico school based agricultural–education (SBAE) students had IEPs, compared to 23% in Illinois as was found by Pense (2008). This study reflected those previous studies population of students with special needs in the SBAE classroom.

Conclusion 2: Inquiry–Based Instruction does not adversely affect content knowledge achievement for students with special needs.

No difference existed in posttest scores when comparing students without IEPs to students with IEPs. This indicates inquiry–based instruction does not adversely affect content knowledge achievement for students with special needs. While Merchand–Martella et al. (2004) indicate that direct instruction should be used to overtly present content for students with special needs, this study indicates that students with special needs can learn the content of the lesson through inquiry–based instruction. These results match the findings of Scruggs et al. (1993) who found that inquiry–based instruction was an effective teaching method for students with special needs.

Recommendations

Recommendations for Practice

Since other researchers (Grier et al., 2008; Wolf and Fraser, 2007; Gibson and Chase, 2002; Von Secker, 2002; Huber et al., 2000; Yerrick, 2000; Von Secker and Lissitz, 1999) found benefits to inquiry–based instruction prior to this study for the general student population, inquiry–based instructions merits are apparent. The findings of this study confirm that inquiry–based instruction is an effective teaching method and should be used when appropriate. Inquiry–based instruction appears to be effective for all students, including those with special needs.

Teacher professional development will be needed to instruct teachers on how it utilize inquiry–based instruction appropriately in their school–based agricultural education classrooms. The findings of this study help teachers to be more confident in utilizing this teaching method, and with the right topic area, can assist students of all the various educational need levels found in their classroom.

Recommendations for Further Inquiry

This study failed to identity a difference in content knowledge achievement between students with special needs and students without special needs being taught using inquiry–based instruction. However there was very little diversity of IEP–type thus the researchers were unable to make comparisons between subgroups of special needs. This comparison of subgroups would be useful in gaining further insight in how students with different needs respond to inquiry–based instruction. A larger study with more intact classes would be beneficial to the body of research surrounding inquiry–based instruction in SBAE. A larger study could provide some insight into how students with different special needs learn through inquiry–based instruction.

This study did not compare the effectiveness of inquiry–based instruction to other methods of instruction. Future studies should focus on these comparisons to determine if inquiry–based instruction is a more effective method of instruction than other methods used in SBAE.

Since the assumption was made that instructors are modifying their instruction for students with special needs while teaching using inquiry–based instruction more research should be done to determine what types of modifications were made for students.

Discussion

Now that the elephant in the room has been addressed, the agricultural education community can make some strides towards figuring out the best way to educate students with special needs. This study found that inquiry–based instruction is a beneficial method of instruction, but what if there is something better? How does it compare to other teaching methods? What other variables should be considered? More research should be done to determine the best way or ways to educate students with special needs in agricultural education, moving towards the ultimate goal of personal growth and practical learning for all students.

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